The Comprehension of Rapid Speech by the Blind - Part II

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Part II

Cooperative Research Project #1370

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Introduction

In the education of blind children, primary reliance is placed upon the Braille code for the communication of written information. Although the Braille code has been by far the most successful of the tactual codes yet developed, it is a poor second when compared to the visual print code. Blind high school students read Braille at about one-third the word rate at which sighted high school students read print, (Ethington, 1956), (Harris, 1947). In one approach to the solution of this problem, educators have used recorded aural presentation. By this means, communication can proceed at about two-thirds the rate that is typical for sighted high school readers, and the use of recorded aural presentation is playing an increasing role in the education of blind children. However, even with the advantage gained by aural presentation, the communication problem encountered by blind children in the course of their education is acute. Even in the lower grades, our society is placing continually increasing reading demands upon the child. As he passes through the grades, the reading required of him increases geometrically. In the case of the blind child, this means that a problem which is initially serious becomes progressively more aggravated as his education proceeds. We now believe that the blind child should be encouraged to acquire those skills and abilities that will enable him to take his place in the seeing world. He must learn to perform a useful function in a society which, because of its increasingly technological character, places growing educational demands upon its members. The blind child, like his sighted counterpart, must receive more and better education if he is to be of any value in our economy.

More and better education means more and more reading. The situation is already critical. The blind high school student making use of what material is available in Braille or in recorded form must struggle to keep up. The blind college student faces an almost impossible task. If present trends continue, and they undoubtedly will, it may soon become impossible for the blind student to accomplish the reading required of him at the communication rates that are now possible for him.

A technique is available by means of which the blind student's communication problem may be eased considerably. It is now possible to increase the word rate of tape recorded speech by any desired amount without distortions in pitch or voice quality. If blind listeners can be trained to profit as much by listening to this accelerated speech, as by listening to speech at conventional word rates, a means of communication will be available to them that compares favorably with the communication rate available to sighted students.

In 1961, (Bixler, R.H., Foulke, E., Amster, C.H., and Nolan, C.Y.) a research project was initiated with support of the Cooperative Research Branch of the Department of Education, to explore the feasibility of presenting information aurally at accelerated word rates. So far, it has been shown that (Foulke, Amster, Nolan, and Bixler, 1962), blind sixth, seventh, and eighth grade children, without prior training, can comprehend material presented at 275 words per minute (wpm) as well as material presented at a conventional speaking rate or in Braille. The ability to receive communication at a rate of 275 wpm puts the blind child on a par with his sighted peer. The study showed further that although comprehension began to fall off beyond 275 wpm, there was still some evidence of comprehension at 375 wpm. These results were felt to be sufficiently encouraging to justify an effort to develop training procedures by means of which listeners could be taught to understand very rapid speech without difficulty.

The report that follows describes the formulation and evaluation of several training procedures. Also, research is described in which an effort has been made to gauge the influence of several factors that appear to be involved in the comprehension of rapid speech.

Chapter One

The Refinement of Techniques and Equipment

Those of us associated with the "rapid speech" project identified three general goals toward which to work during the first year of the project described in this paper: (1) We planned to accumulate a large amount of personal experience in listening to "rapid speech" under a variety of conditions. We felt that we needed this experience as a guide to future research. (2) We planned to modify and adapt our speech compression equipment so that material of good technical quality could be prepared at any desired word rate. (3) We planned to gain experience with the use of the speech compression equipment and related equipment, and with the speech compression process itself so that we could prepare large amounts of compressed speech for our own research needs, and, time permitting, for the research needs of other interested individuals.

The Accumulation of Experience: Project members and interested graduate students have spent much time in listening to "rapid speech" at a variety of word rates. There has been general agreement that as one listens to "rapid speech" for the first time, there is an initial rapid gain in the ability to comprehend it. A few of us who have had extensive experience in listening to "rapid speech" report good comprehension of speech at word rates as high as 375 wpm. However this appears to be close to the upper limit so far. It has been our common experience that beyond 375 wpm, intelligibility begins to fall very rapidly. Because some of us have felt that listening to "rapid speech" requires an attentive adjustment and that this attentive adjustment takes time, we have listened to many samples of speech in which the word rate is gradually increased from a normal word rate to a very rapid word rate. We have varied the time required to progress from the normal word rate to a very fast word rate, for instance 350 wpm, from a few minutes to a few hours.

In listening to "rapid speech", it has seemed apparent to us that a reader's voice quality and reading style are important factors influencing the comprehension of "rapid speech". Material that is read at a fairly even word rate and with only moderate fluctuation in voice pitch appears to withstand the effects of speech compression much better than speech in which the word rate and the pitch of the speaker's voice vary considerably. In other words, a passage read in the style of a radio newscast would be understood better when reproduced at a rapid word rate than the same passage read dramatically, as an actor might read it. The reader with a clear, crisp voice quality appears to be a better choice for a reading selection the word rate of which is to be accelerated, than a reader with a soft or unctuous voice quality.

Speech may be compressed or made rapid in at least two ways. The easiest way technologically speaking to achieve compressed or "rapid speech" is to play a tape or record at a faster speed than the one at which it was recorded originally. However, this approach results in a distortion in pitch and voice quality. The alternative approach is a speech sampling method in which segments of recorded speech are discarded and resulting gaps are eliminated. This method relies for its success upon the amount of redundency in spoken language. The discarded segments are small enough that the human ear cannot detect their absence, and no entire speech sound is ever lost. This method is free from the distortion in voice quality and pitch that is inherent in the first method. However, the necessary

equipment is expensive and scarce, while the equipment required for the first method is cheap and readily available. For these reasons, we have listened to speech made rapid by the two alternative methods. There has been general agreement that speech made rapid by the sampling method is more pleasing to hear, and we have felt that it remains more intelligible at fast word rates.

We have listened at fast word rates to reading selections covering a wide range of content, interest, difficulty, and style of exposition. We have listened to highly technical scientific treatises, non-technical factual expositions, juvenile and adult fiction, dramatic readings, poetry and even music. We have agreed that, as is the case with other modes of presentation, more difficult material should be presented at a slower word rate. However, our experience suggests that even very difficult material might be presented at a word rate that is somewhat faster than normal. Several have expressed the opinion that although good fiction could be presented at significantly faster than normal word rates, when the word rate is too fast, its artistic merit seems to vanish. None of us were satisfied with poetry at accelerated word rates, and music that the composer intended as serious, became quite comical when accelerated.

The impressions just reported have provided the basis for more definite hypotheses. These hypotheses have been evaluated by the experiments that are to be described in later sections of the report.

<ins>The Refinement of Equipment</ins>: In our research, we have been primarily concerned with speech made rapid by the "sampling method". The device we use to compress speech is the Tempo-Regulator, manufactured by Telefonbau und Normalzeit, Frankfurt-am-Main, Germany. The Tempo-Regulator samples recorded tape in the following manner. The tape passes over the curved surface of a cylinder and wraps around the cylinder enough to make contact with one quarter of its circumference. Four tape reproducing heads are spaced equally around the circumference of the cylinder. When this cylinder is stationary and the tape is moving at the same speed at which it moved during recording, (15 inches per second), it makes contact with one of the reproducing heads and the signal is reproduced as recorded. When the Tempo-Regulator is adjusted for some amount of compression, the speed of the tape increases and the cylinder begins to rotate in the direction of tape motion. As the speed of the tape is increased, the rotational speed of the cylinder is increased so that the speed of the tape relative to the surface of the cylinder is held constant at 15 inches per second, (ips). Under these conditions, each of the four heads in turn, makes and then loses contact with the tape. Each head reproduces, as recorded, the material on the portion of the tape with which it makes contact. When the cylinder is so positioned that one head is just losing contact with the tape while the preceding head is just making contact with the tape, the segment of tape that is wrapped around the cylinder between these two heads never makes contact with a reproducing head and is therefore not reproduced. The segment of the tape that is eliminated from the reproduction in this manner is always the same length, one quarter of the circumference of the cylinder. The amount of speech compression depends upon the number of such eliminations per unit time, and this in turn depends upon the tape and cylinder speed. Speech may be expanded by reversing the direction of rotation of the cylinder and by moving the tape across the cylinder at a speed slower than that used during recording.

Though the Tempo-Regulator is capable of a much higher signal quality than the other commercially available speech compression device with which the author is familiar, considerable adaptation was required before it could be used con-

veniently. It is not compatible with tape recorded on most American built recorders. It is designed to reproduce tape recorded at 15 ips. This tape speed is no longer available on most tape recorders, but it is still available on a few of the more expensive machines. The Tempo-Regulator has half-track playback heads, but they do not scan the half of the tape surface that is recorded by American built half-track recorders. This problem may be solved by using the appropriate half of a two track stereo recording head when preparing tape for use on the Tempo-Regulator. However, we have found the use of tape recorded on a full track head to be an even more satisfactory solution. The Tempo-Regulator has no provision for handling tape reels. Reel motors and spindles must be provided. American tape recorders are designed to handle tape reels on which the tape has been wound with the oxide coated surface to the inside. The Tempo-Regulator is designed to handle tape reels with the oxide coated surface wound to the outside. This problem may be solved by reversing the usual direction of rotation of the reel motors.

The Tempo-Regulator was apparently designed for the rather modest amounts of speech compression or expansion that would be required in order to tailor messages to fit available time slots in commercial broadcasting. In order to explore the upper limits in the comprehension of "rapid speech", we needed a device that would permit us to increase the word rate of recorded speech until it became completely unintelligible. Speech reproduced at the fastest word rate of which the Tempo-Regulator is capable is still quite intelligible. Also, as the Tempo-Regulator approaches its upper limit, its speed regulation becomes quite poor. After considerable experimentation, it was decided to alter the Tempo-Regulator's drive system, and to replace one of its motors with a regulated variable speed motor. This modification was successful, and we are now able to prepare "rapid speech" of good quality at any desired word rate within the range of intelligibility. Furthermore, we can accomplish desired amounts of compression with precision.

Applying the Speech Compression Technique: We now have two technicians trained in the use of the Tempo-Regulator and associated equipment such as preamplifiers, amplifiers, tape recorders, etc. We know a good deal about the manner in which tapes for use on the Tempo-Regulator should be prepared in order to achieve best results. We have designed and built special equalization and preamplification circuits that permit us to record the signal from the Tempo-Regulator with good fidelity. We have developed three alternative procedures for adjusting the Tempo-Regulator to produce speech at a desired word rate. In other words, we now have the capability of producing, with ease, enough high quality compressed material to meet our own research needs. Furthermore, we are in a position to assist others who wish to do research in this area.

Chapter Two

The Evaluation of Four Training Methods for the Comprehension of "Rapid Speech"

It has been shown repeatedly that listeners can demonstrate good comprehension of material presented at accelerated word rates, (Foulke, 1962, Fairbanks et. al., 1957, McLain, 1962). However, the listeners in these experiments were hearing "rapid speech" for the first time. It is reasonable to expect that with practice or training, listeners could learn to comprehend "rapid speech" better and at higher word rates.

Only a beginning has been made in the exploration of this possibility. Voor, (1962), has made a preliminary investigation of the effect of practice upon the comprehension of accelerated speech. He found the comprehension of accelerated speech to be a negatively accelerated increasing function of practice. However, the total amount of practice received by his subjects was quite small.

Klineman, (1963) measured the listening comprehension of a group of sixth grade blind school children, gave them experience in listening to speech at an accelerated word rate, and then measured their listening comprehension again with an equivalent test. However, no reliability was demonstrated for her pre-training and post-training tests of listening comprehension, and much of her evidence was informal and anecdotal.

The report that follows describes an effort to administer and evaluate four tentative training procedures. These procedures were the outgrowth of discussions of those of us associated with the "rapid speech" project, all of whom had had considerable experience in listening to "rapid speech" under a variety of conditions.

Originally it was planned to evaluate the four procedures in a single experiment, so that justifiable comparisons could be made. Four treatment groups were to be established. Group A was to receive prolonged, uninterrupted exposure to "rapid speech" at 350 wpm. Group B was to receive the same as A but with frequent interruptions for questioning about the content of the material heard. Group C was to receive prolonged exposure to speech presented initially at a normal word rate and made more rapid by undetectable increments. Group D was to receive the same exposure as Group C, but with frequent interruptions for questioning about the content of the material heard.

However, the execution of an experiment of this type requires the participation of subjects over a period of many weeks. Not enough children were available for service in the experiment at any one residential school for the blind. In order to insure that all four treatment groups were constituted equally, it would have been necessary to make assignments to groups in such a way that each of the grades and all of the schools participating in the experiment were represented in proper proportions in each treatment group. It would have been necessary to provide all four experimental treatments at each of the schools visited. School administrators felt that an experiment of this scope and duration would entail too much interference with normal school routine. Therefore, it was decided to reduce the demands upon participating schools by conducting two smaller experiments with one of the two factors just mentioned examined in each experiment. This departure from good experimental design gives a more tentative cast to many of the results. Nevertheless, the legitimacy of some of the comparisons remains intact, and other comparisons will have suggestive value.

Experiment I

Subjects: The subjects in the experiment were seventh, eighth, and ninth grade school children enrolled at the Kentucky School for the Blind. Though some of them were partially sighted, they were all classified as Braille readers. The age, grade, and sex of each child is shown in Table 2.1, (page 8).

Experimental Design: The subjects were divided into two groups in such a way that the groups were similar with respect to sex and grade representation. The independent variable was the manner in which listening material was presented. One group, referred to hereafter as the IR (increasing rate) group, heard material the word rate of which was normal at the onset of training. However, the word rate was increased gradually by undetectable steps, until, near the end of training, it was twice normal rate, or, 350 words per minute. The other group, referred to hereafter as the CR (constant rate) group, heard material presented at a constant rate of 350 words per minute.

The dependent variable was a change in test performance from a pre-training to a post-training test of listening comprehension, that could be attributed to the experimental treatments provided.

Experimental Materials: The listening selection used for training purposes was the novel, Adam Gray: Stowaway, (Arntson, H. E., 1961), which was of suitable interest and difficulty for the age - grade range represented in the experiment. It was recorded on magnetic tape in the Talking Book Studios of the American Printing House for the Blind, and was read by one of the regular Talking Book readers. This "master tape" was then reproduced on the Tempo-Regulator and the output of the Tempo-Regulator was copied onto tape again at 7½ inches per second. This final tape was the one heard by subjects and was reproduced on a Wollensak Tape Recorder, Model #1500. In the case of the CR group, the Tempo-Regulator was adjusted to reproduce at a continuous word rate of 350 wpm. In the case of the IR group, the Tempo-Regulator was initially adjusted to reproduce the master tape as recorded. As the tape was played, the word rate was gradually and very slowly increased, until near the end of the selection, a word rate of 350 wpm was reached. Approximately two hours and forty-eight minutes were required to progress from the initial word rate of 175 wpm to the terminal word rate of 350 wpm.

The tests of listening comprehension were the listening subtests from the Sequential Tests of Educational Progress. These tests, when administered according to directions in the test manual, have a reliability of .895. The test taking procedure was altered slightly so that blind children could manage it. The selections in the listening subtest were prepared for presentation at 350 wpm and played to the group of subjects. Each selection was followed by its multiple choice questions. The questions and alternative answers were also recorded on tape and each question, together with its four alternative answers was read twice. The subjects indicated their choices of alternatives on specially prepared answer sheets by placing a pencil mark in the appropriate box. The boxes were outlined by Braille dots and were large enough so that they could be felt and marked in without difficulty.

When the STEP listening test is administered to a sighted group, selections and questions are read by the testor, but the alternative answers are printed in booklets and read by those taking the test. Choices of alternatives are indicated on separate answer sheets. In the present case, this procedure was modified because the rate at which Braille is read is so slow and variable that standard

Table 2.1

Description of Subjects

IR Group

Subject	Age	Grade	Sex
J. H.	15	9	M
D. D.	13	7	M
J. F.	12	7	M
M. S.	15	8	F
H. B.	17	9	M
E. M.	13	7	M
D. H.	13	7	F

CR Group

Subject	Age	Grade	Sex
C. B.	14	9	F
M. C.	19	9	M
E. J.	13	7	M
J. A.	15	8	M
C. A.	16	7	M
T. W.	16	8	M
E. P.	13	7	M
V. R.	15	8	M

administration would have been too costly in time. Also, the problem of finding one's place when switching back and forth from the booklet with the alternatives to the answer sheet would have proved quite difficult for Braille readers.

Procedure: Subjects were assembled and administered one form of the test of listening comprehension. Because of its length, two experimental sessions were required. Starting with the third session, subjects were formed into two groups similar with respect to grade and sex. One group listened to the training selection at a constant word rate of 350 wpm. Each experimental session lasted fifty minutes, and 5½ sessions were required to present the entire novel at this rate. The IR group heard the novel at a word rate which was at first normal, but which increased until, during the last training session, it reached a rate of 350 wpm. Upon completion of the novel, each group reported for two sessions during which the equivalent form of the test of listening comprehension was administered.

Results: The means and standard deviations of the pre-training and the post-training test scores for both the IR Group and the CR Group are shown in Table 2.2, below. Differences between means are quite small, and the difference between the pre-training and the post-training means for the CR Group is not in the expected direction. The analysis of variance of test scores, shown in Table 2.3, reveals no significant difference that can be attributed to the experimental treatments provided.

IR Group

	Mean	S.D.
Pre-training Test:	41.57	11.49
Post-training Test:	43.14	16.85

CR Group

	Mean	S.D.
Pre-training Test:	41.62	8.56
Post-training Test:	40.25	11.06

Table 2.2. Means and Standard Deviations of Pre-Training and Post-Training Test Scores

Discussion: One must conclude from these results that the training given to subjects did not bring about an improvement in their ability to comprehend "rapid speech". It is clear that these training methods, as they stand, are not effective.

Another more encouraging conclusion is that, even though training was not effective, there was definite evidence for the comprehension of "STEP" listening passages presented at 350 words per minute. Table 2.4 (page 10) shows the significance of the pre-training STEP Listening Test scores for all subjects, regardless

Source of Variation	Sum of Squares	df	Mean Square
Between Groups	31.25	3	10.42
Within Groups	4482.95	26	172.42
Total	4514.20	29	

Table 2.3. Analysis of Variance of Test Scores

of group membership. Each row in this table (2.4) presents data for a single subject. The entries in column 1 designate subjects by their initials. Column 2 shows each subject's grade in school. The column 3 entries are pre-training STEP Test raw scores, and the column 4 entries are the corresponding converted scores. Column 5 indicates the percentile range to which each subject is assignable on the basis of his test performance and school grade. The generalization suggested by this table is that some people can show listening comprehension of material presented at 350 wpm that is judged as average or better, when evaluated by norms developed from listening passages presented at less than half that word rate. To state it another way, some people can show comprehension of material presented at 350 wpm that is not just good when allowances are made for the fast word rate, but good in terms of the criteria usually applied to the comprehension of material presented at a conventional slow rate. This ability is impressive, but it is obviously not universal among listeners, and it is clear that we have not yet demonstrated a training method that can improve naive ability.

Subject	Grade in School	Raw Score	Converted Score	Percentile Band
E.M.	7	58	286	74-91
D.H.	7	55	282	68-83
M.C.	9	54	281	39-61
C.B.	9	51	278	34-56
E.J.	7	46	273	43-59
E.P.	7	45	272	43-59
J.F.	7	45	272	43-59
J.H.	9	45	272	20-39
C.A.	7	40	267	24-46
T.W.	8	38	265	12-26
V.R.	8	31	257	5-12
D.D.	7	30	256	11-18
H.B.	9	30	256	2-10
M.S.	8	28	253	3-8
J.A.	8	28	253	3-8

Table 2.4. Pre-Training "STEP" Listening Test Data for Kentucky School Subjects.

Though the outcome of the experiment provides no evidence for a training effect, there may have been some initial improvement as a function of the practice afforded by the pre-training listening test. Voor's results, (1962) support such an expectation. This question may be examined by an inspection of pre-training listening test performance. The STEP Listening Test is divided into two equal parts for administrative convenience. If practice while taking the test was an important factor, we might expect its influence to be manifested by a larger mean score to Part II than to Part I. This was not the case. The mean score on Part I of the test was 22.33, and the mean score on Part II was 19.27. This difference is the reverse of the expected one, but it is too small to be significant. If practice was a factor, its influence was obscured by other contributions to test score variability.

Experiment II

Subjects: Subjects in this experiment were seventh and eighth grade children enrolled in The Western Pennsylvania School for the Blind. Though many of them had some remaining vision, they were all classified as "Braille readers".

Experimental design: A two-group design was employed, with each group receiving a different experimental treatment. The groups were similar with respect to age, sex, and grade. The constitution of each group is shown in Table 2.5. Both groups listened to the training selection employed in experiment I. However, the narrative was interrupted from time to time so the subjects could be questioned about the material to which they had just listened. As was the case in experiment I, one group, the CR group, heard the training selection at a continuous rate of 350 wpm. The other group, the IR group, heard the selection at an increasing word rate that started at 175 wpm and terminated at 350 wpm.

Experimental materials: The same test of listening comprehension was employed and it was administered in the same way and at the same word rate, (see page 7). The narrative was interrupted every few minutes and subjects were questioned about the material just heard. The time elapsing between interruptions was variable. However, an effort was made to choose points of interruption so that resulting passages would include groups of related ideas.

The questions answered by the subjects were of the true-false, completion, or short answer type. Answers were written in Braille.

Procedure: As in the first experiment, subjects were brought together and administered one form of the test of listening comprehension at the rate of 350 wpm. They were then divided into two groups as dexcribed previously, and training was commenced. At the beginning of the first training session, subjects heard the tape recorded instructions for answering the questions asked them at intervals throughout training. The CR group required 32 training sessions to complete the novel, while the IR group required 32 training sessions also. Upon completion of training each group received the equivalent form of the test of listening comprehension at 350 wpm.

Results: Table 2.6 shows the pre-training and post-training mean test scores and standard deviations for the CR and the IR group.

Table 2.5

Description of Subjects - Western Pennsylvania School

IR Group

Subject	Age	Grade	Sex
S. W.	13	7	F
D. Y.	12	7	F
D. J.	15	7	M
K. S.	13	7	F
H. W.	13	7	F
K. S.	14	7	M
T. B.	14	8	M
C. V.	15	8	M
C. Z.	14	8	F
P. G.	16	8	M
J. S.	14	8	M

CR Group

Subject	Age	Grade	Sex
L. R.	14	7	F
D. N.	13	7	M
B. T.	14	7	F
T. S.	14	7	M
M. S.	14	7	F
D. C.	13	7	M
M. M.	14	8	F
W. H.	14	8	F
R. M.	14	8	M
A. W.	15	8	F

Table 2.6. Means and Standard Deviations of Pre-training and Post-training Test Scores

IR Group	Mean	S.D.
Pre-training Test:	42.9	8.504
Post-training Test:	45.2	12.282

CR Group	Mean	S.D.
Pre-training Test:	44.7	13.606
Post-training Test:	46.6	12.633

The difference between pre-training and post-training test means is in the expected direction for both the CR and the IR group. However, differences are small, and the analysis of variance shown in Table 2.7 indicates that they are insignificant.

Table 2.7. Analysis of Variance of Test Scores

Source of Variation	Sum of Squares	df	Mean Square
Between Tests	44.1	1	44.1
Between Experimental Groups	25.6	1	25.6
Interaction	.4	1	.4
Within Cells	5111.00	36	141.97
Total	5181.10	39	

Inspection of the mean square column shows that the estimate of error variance is much larger than any of the other variance estimates. Thus we must conclude that there were no significant differences related to the experimental treatments provided.

Discussion: The outcome of experiment II is similar to that of experiment I. Again, it is apparent that an effective training method has not yet been demonstrated. Table 2.4 indicated that the subjects in experiment I, though they did not profit by training, showed considerable comprehension of the STEP Test selections presented at 350 wpm. This point is shown even more clearly in Table 2.8 which presents the same information for the subjects in experiment II. (For an explanation of this table, see the discussion of Table 2.4 on page 10.) One conclusion to be drawn from the information presented in these tables is that it may be profitable to identify a group of listeners who can show good comprehension of "rapid speech", and subject them to more careful scrutiny.

As was the case in experiment I, there was no evidence for a practice effect during the pre-training listening test. The mean score for part I of the test was

Table 2.8

Pre-training "STEP" Listening Test Data For Western Pennsylvania School Subjects

Subjects	Grade in School	Raw Score	Converted Score	Percentile Band
T.B.	8	64	285	58-76
M.M.	8	63	294	76-93
W.H.	8	63	294	76-93
J.S.	8	56	284	58-76
S.W.	7	56	284	70-89
D.C.	7	49	276	50-74
C.V.	8	48	275	32-52
D.J.	7	48	275	46-68
T.S.	7	47	274	46-68
M.S.	7	45	272	43-59
A.W.	8	41	268	23-34
C.Z.	8	40	267	15-32
D.Y.	7	37	264	22-36
H.W.	7	35	262	18-31
P.G.	8	35	262	10-21
D.N.	7	35	262	18-31
K.S.	7	34	261	16-26
B.T	7	26	251	4-13
L.R.	7	24	248	4-10

23.90 and the mean score for part II was 20.62. As before the direction of the difference was the opposite of that expected, but too small to be significant.

The outcomes of the two experiments were consistent and conclusive. None of the four training methods tried brought about any demonstrable improvement in the ability to comprehend "rapid speech". This lack of success may be attributed to either the kind or amount of training provided, or both. Experience gathered during the conduct of the experiments suggests that it will be necessary to prolong training experiences considerably and that more definite steps will have to be taken to insure the motivation of participating subjects.

Summary: Two experiments were performed in order to evaluate training methods for the comprehension of "rapid speech". In one experiment, subjects were trained by listening to uninterrupted speech. One group listened at a constant high word rate while the other group listened at an initially slow but increasing word rate. In the other experiment, word rates were varied in the same way. However, the training passage was interrupted frequently and subjects were questioned about the material just heard. The effectiveness of training was evaluated by comparing pre-training listening test scores with post-training listening test scores from equivalent test forms. None of the four training methods employed yielded any significant improvement in the ability to comprehend "rapid speech". However, it was also apparent that some of the subjects showed superior comprehension of "rapid speech" without training.

Chapter Three

The Comparison of Alternative Methods of Producing Rapid Speech

When the word rate of a recorded message is increased, the time required for the transmission of that message is decreased, and we say time or speech compression has occurred. On the other hand, when the word rate is decreased, the message time is increased, and we speak of time or speech expansion. In the work described in this report, we have been concerned with compressed or "rapid speech".

As has been mentioned previously, (see Chapter One, page three), the word rate of recorded speech may be altered by at least two methods. A change in the word rate of the recorded selection may be accomplished most easily merely by playing a tape or record at some speed other than the one at which it was recorded. If the playback speed is slower, the word rate is decreased, or the speech is expanded. If the playback speed is increased, the word rate is increased and the speech is compressed. Since this method always involves a change in the speed of the recording, it is referred to hereafter as the "speed changing method".

From the viewpoint of technological simplicity, the "speed changing method" has much to recommend it. Turntables with continuously variable speeds are available commercially. With relatively simple modification, many tape recorders may be made to operate at continuously variable speeds. However, the speech resulting from the "speed changing method" is distorted and the more seriously so the greater the change in speed. The distortion that takes place effects both the pitch and the quality of the speaker's voice.

Many blind people read by listening to recordings. Some of these people, in order to save listening time, reproduce records at a faster speed than the original recording speed. The usual practice here is to play a record that has been recorded at 33 1/3 rpm, the speed at which most Talking Book Records have been recorded, at 45 rpm, a speed setting that is available on many record players. This enables the reader to save about one fourth of the listening time if he is willing to tolerate the distortion that results. A few blind listeners claim the ability to listen, with good comprehension, to recordings played at twice the original recording speed. However, most people find the distortion of speech that has been accelerated in this manner irritating and say that they have difficulty understanding it.

The alternative method for accelerating speech is the "sampling method", described in some detail in Chapter One, page four. The "sampling method" is free from the distortion inherent in the "speed changing method". People who have heard speech made rapid by the "sampling method", and who have had the opportunity to compare this speech with speech made rapid by the "speed changing method", say that it is much less irritating and that it is more intelligible. If a recorded selection, that has been read by a person whose voice is familiar to the listener is compressed by means of the sampling method until the word rate is so fast that it is nearly unintelligible, the listener will still be able to recognize the voice of the reader. If the same selection were compressed by means of the "speed changing method", even modest amounts of compression would make it impossible for the listener to identify the speaker's voice.

However, there is one serious disadvantage associated with the "sampling method". The necessary equipment is very expensive and almost unavailable. To the

author's knowledge, the only device that changes word rate by a "sampling method" and that produces speech of good quality is the Tempo-Regulator. Only a few Tempo-Regulators have been imported to this country, and Telefonbau und Normalzeit, the company that built them, has no Tempo-Regulators for sale at the present time. There is some hope that Tempo-Regulators, designed to operate on 60 cycle, 117 volt current, will be available again in the near future.

The problem is partly one of demand. If it can be shown that enough people can use and would like to have material the word rate of which has been accelerated by means of the "sampling method", some manufacturer may be tempted to meet this anticipated demand. Under the best circumstances, it would probably not be possible to provide speech compression devices of the sampling type at a low enough price so that they could be owned and used by individuals in the same way that tape recorders and record players are used. However, such devices, if available, could be purchased by schools and libraries and the people served by these institutions could be given access to them. In many cases, those who now prepare recorded material for use by blind readers could justify the purchase of a speech accelerator in order to prepare at accelerated word rates recorded tapes that could be played on conventional tape recorders.

To recapitulate, people seem to prefer speech made rapid by the "sampling method" to speech made rapid by the "speed changing method". However, the application of the "sampling method" is seriously hampered by the problems of expense and unavailability of equipment, while the "speed changing method" can be accomplished easily and cheaply with equipment that is readily available. For these reasons, research must be performed that will demonstrate clearly the relative advantages and disadvantages of the two alternative methods.

Some preliminary investigations have already been made. McLain, (1962), conducted an experiment in which one group of high school students listened to a selection reproduced at 325 words per minute by the "sampling method". A second group listened to the same selection reproduced at 325 words per minute by means of the "speed changing method". Both groups were then given a multiple choice test covering the material heard, and their scores were compared. The "sampling method" group had a higher mean score than the "speed changing method" group, and this difference was significant at the 5% level.

In a similar experiment, (Foulke, 1962), both word rate and method of changing word rate were varied. Four groups of junior high school students served in the experiment. Two of these groups heard a selection made rapid by the "sampling method". One of these heard the selection at 253 wpm, while the other group heard it as 325 wpm. The other two groups heard the same selection made rapid by means of the "speed changing method" at the same two word rates. All four groups took a multiple choice test covering the selection heard, and their test scores were evaluated by an analysis of variance. There was a difference in favor of the "sampling method" that was significant at the 5% level for both the 253 wpm group and the 325 wpm group. The difference in favor of the "sampling method" was larger at the faster word rate.

The two experiments just reviewed were intended as pilot studies. Their outcomes seemed sufficiently encouraging to justify the planning of a more elaborate experiment. Therefore, an experiment was performed in which more word rates were represented, and in which blind instead of sighted school children served as subjects.

Method

Experimental Design: A factorial experiment was performed in which the method of accomplishing "rapid speech" and the word rate of speech were varied. The two methods for accelerating speech were the "speed changing method" and the "sampling method". The word rates at which speech was presented were 253, 300 and 350 wpm. This plan resulted in six treatment groups. Each group contained approximately twenty members and each subject was exposed to only one experimental treatment. Since subjects were drawn from four residential schools for the blind, the groups were so constituted that the proportions of subjects from each of the schools was the same for all six groups. Since subjects were drawn from three school grades, experimental groups were so constituted that the proportions of children from each of the grades was the same for all six groups.

Subjects: One hundred twenty-three blind children of both sexes enrolled in the seventh, eighth and ninth grades served as subjects. The four residential schools for the blind from which subjects were drawn were the Kentucky School for the Blind, Louisville, Kentucky; the Ohio State School for the Blind, Columbus, Ohio; the New York State School for the Blind, Batavia, New York; and the Western Pennsylvania School for Blind Children, Pittsburgh, Pennsylvania.*

Experimental Materials: The selection to which subjects listened was, Two Chests of Treasure, by Merritt P. Allen. This story tells of the encounter between a shipwrecked boy and a band of treasure - seeking pirates. The story was chosen on the basis of length, interest and difficulty. The vocabulary used in the story is appropriate for junior high school students. The theme of the story is one that is likely to interest junior high students. The story contains 3350 words. A selection of this length is short enough to be manageable in an experimental session, yet long enough to permit the construction of a reliable test of comprehension.

The Test of Listening Comprehension: A test designed to measure the comprehension resulting from listening to the experimental selection was constructed in the following manner. Each member in a group of one hundred junior high school students in Southern Junior High School, Louisville, Kentucky** read a mimeographed copy of the listening selection. He then took a 83 item multiple choice test covering the material read. The tests were scored and the items were ranked according to item difficulty. Those items passed by fewer than 15% or more than 85% of the group were discarded. Next, the internal consistency of the test was evaluated by determining the biserial correlation between each individual item and the whole test. When an item-whole test correlation was below .25, that item was discarded. Forty-two items met the criteria for item difficulty and for internal consistency. These items were ranked according to item difficulty and an odd - even split was made. The Pearson Product Moment Coefficient of Correlation between the two halves was calculated, and this coefficient was corrected by the Spearman-Brown Formula. The coefficient of reliability thus obtained was .7630.

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*The author wishes to express his gratitude for the willing cooperation shown him by the superintendents, principals, faculty members, and children in the four residential schools for the blind participating in the experiment.

**The author also wishes to express his gratitude to the principal, faculty members and children at Southern Junior High School, Louisville, Kentucky.

The listening selection was read by a professional reader and recorded on tape in the Talking Book Studios of the American Printing House for the Blind, Louisville, Kentucky. To prepare the selection made rapid by the "sampling method", the "master tape" was reproduced on the Tempo-Regulator at each of the word rates used in the experiment, and the output of the Tempo-Regulator was copied on tape. To prepare the selections made rapid by the "speed changing" method, a record was made from the "master tape". This record was then played at each of the turntable speeds required to produce the word rates called for in the experiment. The output of the record player was copied onto tape. The instructions for participating in the experiment were also recorded on tape.

The test of listening comprehension was presented by means of recorded tape. Each question, together with its four alternative answers, was read twice. Subjects indicated their choices of alternatives on specially prepared Braille answer sheets by making pencil marks in the appropriate boxes. The boxes were outlined by Braille dots, and were large enough so that they could be marked in without difficulty.

Procedure: When the subjects assigned to a particular treatment group were assembled, the tape recorder was started and they heard the instructions for participating in the experiment. Next, they heard the listening selection prepared by the method and at the word rate that constituted their experimental treatment. When the selection was finished, they were given answer sheets and pencils and heard the recorded instructions for taking the test. Subjects were requested to attempt every question. After a question had been heard twice, the tape recorder was stopped until each subject had made a choice. Then, the tape recorder was started again and the next question was presented.

Results: Table 3.1 gives the means and standard deviations for the six treatment groups. The means associated with the three word rates employed in the experiment decrease rapidly as word rate increases. However, at each of the three word rates, the differences between the means for the groups who heard "rapid speech" prepared in different ways are small and not always in the expected direction. The impression conveyed by this table is confirmed by the analysis of variance of test scores summarized in Table 3.2, (page 20).

Table 3.1. Means and Standard Deviations for the Six Treatment Groups*

	Mean	S.D.
Group I - 253 wpm	23.65	8.61
Group II - 253 wpm	21.19	6.25
Group III - 300 wpm	15.95	5.71
Group IV - 300 wpm	17.35	6.59
Group V - 350 wpm	12.80	5.62
Group VI - 350 wpm	10.36	7.12

* Groups I, III, V - "sampling method"
Groups II, IV, VI - "speed changing method"

Table 3.2. Analysis of Variance of Test Scores

Source of Variation	Sum of Squares	df	Mean Square	F
Between Word Rate	2368.19	2	1184.09	29.85
Type of Compressed Speech	12.55	1	12.55	
Interaction	154.96	2	77.48	1.95
Within Groups	4641.35	117	39.66	
Total	7177.05			

Row 1 of this table confirms the impression of significance for the word rate variable. The variable associated with type of compressed speech is not significant as shown in Row 2 of Table 3.2. The F-ratio for the interaction shown in Row 3 also fails to reach significance.

Discussion: The conclusion to be drawn from this experiment is uncertain. It seems clear on the one hand that the manner of preparing "rapid speech" was of little consequence as far as comprehension is concerned. On the other hand, the present outcome is inconsistent with previous findings and does not support the confidently expressed expectations of listeners who have had experience with both kinds of compressed speech. The issue at stake in this experiment is of considerable importance, and a more careful and exhaustive inquiry is evidently required. When this question is submitted to experimental scrutiny again, it would seem desirable to compare the performance of subjects who have had extensive training in listening to the kind of compressed speech to which they listen in the experiment. The subjects in the present experiment were essentially naive as far as compressed speech is concerned.

Summary: An experiment was performed in an effort to determine the relation between listening comprehension and the method of compressing speech. One group of subjects heard speech made rapid by means of the Tempo-Regulator. The other group heard speech made rapid by playing a record at a faster speed than the one at which it was recorded. Each group was further divided into three subgroups, and each subgroup heard the listening selection at a different rapid word rate. The three word rates employed were: 253, 300, and 350 wpm. Following this, subjects took a multiple choice test of listening comprehension, based upon the selection heard. The analysis of variance of test scores showed the word rate variable to be highly significant. However, the method used to compress speech was not a significant variable.

Chapter Four

The Influence of the Speaker's Voice and Style of Reading Upon the Comprehension of "Rapid Speech"

As those of us working on the project have gained experience in listening to speech at various accelerated word rates, it has become evident that the reader's style and the quality of his voice are likely to be important factors influencing the comprehension of "rapid speech". Selections read in a style characteristic of professional radio news announcers, who read at a fairly even rate and with only a moderately expressive manner, appeared to be more comprehensible when the word rate was accelerated than selections read in a style characteristic of actors, who make an effort to read expressively with considerable variation in word rate, pitch, and timbre. We have also noticed that the quality of the speaker's voice seems to affect the comprehension of "rapid speech". It is difficult to talk about variations in voice quality since our language does not provide familiar words that refer directly to the dimensions of variation that determine voice quality. Nevertheless, that there are wide differences in voice quality is an obvious fact of experience. In a general way, voices with a clear, crisp quality seem to fare better at accelerated word rates than soft voices.

In order to explore these variables, we adopted an experimental plan that took into account both word rate and the combined factor of voice quality and reading style. It would, of course, be desirable to vary reading style and voice quality independently. However, the practical problems in accomplishing this would be formidable. For purposes of preliminary investigation, we decided to treat the reader's voice quality and his style of reading as a single variable.

Method

Experimental Design: A two factor experiment was performed in which word rate was varied in two ways, and the oral reading factor in three ways. The selection read by the readers was reproduced at 175 and 300 wpm. The selection was read by three different readers, all of whom are employed in the Talking Book Program at the American Printing House for the Blind, Louisville, Kentucky. They have markedly different reading styles and voice qualities. One of the three is a woman. The two males are also radio and television announcers. This arrangement resulted in six treatment groups. Subjects were randomly assigned to the six groups. The groups were nearly equal in size, but not exactly so, since some subjects failed to keep their appointments. Each subject served in only one treatment group.

Subjects: Students of both sexes in introductory classes in psychology at the University of Louisville served as subjects. Their participation in the experiment fulfilled a course requirement.

Experimental Materials: The selection to which subjects listened was "Athenian, Spartan and Roman Life", by Will Durant. It was chosen because, in the opinion of the investigators, it was suitable with respect to interest and difficulty for administration to a college sophomore population. The original, or master tape from which the tapes used in the experiment were prepared, was recorded in the Talking Book Studios of the American Printing House for the Blind, Louisville, Kentucky. This "master tape" was reproduced on the Tempo-Regulator at each of the desired word rates, and, from the output of the Tempo-Regulator,

the tapes were made that were used in the experiment proper. They were reproduced on a Wollensak Tape Recorder, Model #1500, driving an external Lafayette three-way speaker system. The speech coming from the loudspeaker system could be heard without difficulty from any point in the experimental room. To test their listening comprehension, subjects took a test composed of four alternative multiple choice items. The reliability of this test was not determined in advance. However, an estimate of reliability was made using the test performance of those who served in the experiment. The Pearson _r_ between the halves of the test that resulted from a split on the basis of item difficulty was determined, and corrected by the Spearman-Brown Formula. The coefficient of reliability, obtained in this manner was .68.

Procedure: All of the subjects assigned to a given treatment group were assembled in a classroom. The tape recorder was started and instructions for participation in the experiment were presented. If there were any questions about these instructions, they were answered. Then the listening selection for that particular treatment group was presented. Following the selection, test booklets and answer sheets were distributed, and subjects completed the test. Each subject remained at his seat until all had finished.

Results: Table 4.1 presents the means and standard deviations of test scores for the six treatment groups. Inspection of this table suggests that both experimental variables had an effect upon the outcome of the experiment. The differences between the means for the groups who listened to the selection read by the same reader but at different word rates are considerable. The differences among the means for the groups who heard the selection read by different readers but at the same word rate are smaller. However, these differences are ordered in the same way at both word rates. An analysis of variance was performed on the test scores and the results of this analysis are summarized in Table 4.2.

Table 4.1

Means and Standard Deviations for the Six Treatment Groups

Treatment Group*	Mean	Standard Deviation
I	33.81	5.36
II	30.00	4.65
III	29.81	4.71
IV	24.25	5.40
V	23.09	4.91
VI	21.91	4.33

*treatment conditions and readers:

Group I = 175 wpm - read by Paul Clark
Group II = 175 wpm - read by Livingston Gilbert
Group III = 175 wpm - read by Terry Hayes Sales (female reader)
Group IV = 300 wpm - read by Paul Clark
Group V = 300 wpm - read by Livingston Gilbert
Group VI = 300 wpm - read by Terry Hayes Sales

Table 4.2. Analysis of Variance of Test Scores

Source of Variation	Sum of Squares	df	Mean Square	F	F(.01)
Between Word Rates	1928.73	1	1928.73	77.83	6,84
Reader	181.27	2	90.63	3.66*	4.78
Interaction	53.85	2	26.93	1.09	4.78
Within Groups	2875.15	116	24.78		
Total	5039.00	121			

* F(.05) = 3.07

The variability in test scores that could be related to word rate was significant beyond the .01 level, as shown in row one of this table. The variability in test scores produced by the three readers who read the experimental selection was significant at the .05 level, as shown in row two. The entries in row three indicate that the interaction between these variables was not significant. In other words, the differences in reading style and voice quality of the three readers employed in the experiment exerted a similar influence on listening comprehension at both the slow and the fast word rates.

Discussion: The outcome of the experiment is sufficiently unequivocal to permit the conclusion that the choice of a reader does make a difference. However, it provides no information that would be useful in mediating that choice. Before this can be done, those characteristics of voice quality and reading style that are associated with good listening comprehension must be identified.

The failure to find an interaction between word rate and reader requires additional comment. It was mentioned earlier that the speech of some readers seemed to remain more comprehensible when compressed than others. If this had been the case with respect to the readers in the present experiment, there should have been a significant interaction. The differences among means assignable to the readers should have been of significantly greater magnitude or conceivably in a different order at 300 wpm than at 175 wpm. This does not appear to be the case. The readers did make a difference, but this difference did not depend upon the word rate at which selections were reproduced.

Summary: A two-factor experiment was performed to determine the influence of the reader's voice quality and reading style upon the comprehension of "rapid speech". Three different readers recorded a reading selection, and each reader's rendition was reproduced at a normal word rate and at 300 wpm. The six versions of the selection generated in this manner were heard by the subjects in six experimental groups. Following this, subjects completed a multiple choice listening test covering the selection. The analysis of variance of test scores showed both the word rate variable and the reader variable to be significant. However, no interaction between these variables was found. This means that, at least in the present case, the comprehensibility of the three readers was not differentially influenced by speech compression.

Chapter Five

The Retention of Information Presented at Accelerated Word Rates

If "rapid speech" is to become a practical means for the presentation of information, the demonstration of good comprehension of selections presented at accelerated word rates is not sufficient if the test of comprehension has been administered immediately after presentation of the selection. It must also be shown that material learned with this mode of presentation can be retained at an effective level. It is the durable effects of learning experiences that make a difference from the educational point of view. It is with respect to such durable effects that the comparison between "rapid speech" and conventional aural presentation should be made. For these reasons, it has seemed desirable to examine, after several retention intervals, the comprehension of selections presented at several accelerated word rates.

Method

Experimental Design: A factorial experiment was conducted in which both word rate and retention interval were varied. The four word rates were 175, 225, 275, and 325 words per minute, (wpm). The three retention intervals were zero days, or immediate test, seven days, and thirty days. This plan resulted in twelve treatment groups. Each subject served in only one group and each group was an independent sample from a common population of Louisville junior high school children. A subject's score on a multiple choice test covering the listening selection heard by him was taken as evidence of comprehension.

Subjects: Three hundred fifteen children, of both sexes, from four junior high schools in Louisville, Kentucky[1] served as subjects. Each of the four schools visited serves a middle-class neighborhood. Though it was not possible to secure intelligence test scores for each of the children who participated in the experiment, the children used were drawn from classes composed of students whose I.Q.s fell within the average intelligence range.

Experimental Materials: The selection to which subjects listened was The Yellow Turtleneck Sweater, by Milton White. This selection is 2105 words in length, and is at the seventh grade level of readability as determined by the Dale-Chall formula, (Dale, 1948). The selection was recorded on magnetic tape in the recording studios at the American Printing House for the Blind, and was read by a professional reader, employed in the Talking Book Program. This "master tape" was reproduced on the Tempo-Regulator at each of the four word rates used in the experiment. The output of the Tempo-Regulator, at each of the four word rates, was recorded on magnetic tape at 7½ inches per second. By this means, four tapes, each containing the listening selection at one of the word rates to be used in the experiment, were prepared. These tapes were the ones used in the experiment proper, and were reproduced on Model #1500 Wollensak Tape Recorders.

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[1] The author wishes to express his sincere appreciation for the willing cooperation shown him by the principals and staffs of Southern, DuPont Manual, Gottschalk, and Manly Junior High Schools.

The test used to measure listening comprehension was a four alternative multiple choice test containing 36 items. It had been developed previously for use in another study. Test items were chosen from a larger population of items on the basis of item difficulty and item-whole test consistency. The test was split on the basis of item difficulty and the correlation between the resulting halves, when corrected by the Spearman-Brown formula, was .80.

Procedure: Experimental sessions were conducted in classrooms at the schools from which subjects were drawn. When the subjects assigned to a particular treatment group were assembled, they heard the recorded instructions for participation in the experiment. The instructions for those who were to hear the selection at an accelerated word rate included a short sample of speech reproduced at that word rate. Subjects were questioned about their ability to hear the tape recorder, and if necessary, adjustments were made. Next, the listening selection was presented. Following this, each subject was provided with a copy of the test questions and an answer sheet. Upon completion of the test, each subject was requested to remain at his seat until all had finished. At that time, the tests were collected and the subjects were dismissed.

Results: Table 5.1 shows the means and standard deviations for the twelve treatment groups. In order to make the apparent outcome of the experiment more evident, the means in this table have also been graphed in Figure 5.1. The three curves in this figure refer to the three retention intervals represented in the experiment. It is clear from this graph that word rate made a difference, but that the difference it made depended heavily upon the interval between learning and testing for retention. The immediate test curve, and, to a lesser extent, the seven day curve are negatively accelerated. It appears that when the retention interval is small, linear acceleration in word rate produces a negatively accelerated loss in comprehension. The thirty day curve is essentially flat, suggesting the absence of a relationship between word rate and comprehension. However, the mean scores in terms of which the thirty day curve is plotted are not much higher than the scores that would have resulted if subjects' choices of test answers had been determined by chance alone. In other words, it appears that, regardless of how much was learned at any of the four word rates initially, forgetting, as measured in this experiment, was almost complete after thirty days.

The impression conveyed by Table 5.1 and Figure 5.1 was confirmed by the analysis of variance of test scores, the results of which are shown in Table 5.2. Row 1 of this table shows the significance of the variability due to changes in word rate; row 2 shows the significance of variability associated with differences in retention interval; and row 3 shows the significance of interaction between word rate and retention interval.

Discussion: Results of this experiment were not surprising. At the highest word rate employed in the experiment, very little was learned and hence, there was very little retention that could be shown, regardless of the retention interval. However, at word rates that were faster than normal, yet slow enough to permit learning, forgetting followed the course that it has been shown to follow in many other studies of verbal learning. That is, the largest amount of forgetting took place shortly after learning, and the rate of forgetting slowed as time between learning and testing for retention increased.

It is probably safe to conclude from these results that the problem of forgetting does not constitute a special case for material presented at an accelerated

Table 5.1

Means and Standard Deviations of Comprehension Test Scores for the Twelve Treatment Groups

Retention Intervals	175 wpm		225 wpm		275 wpm		325 wpm	
	X	S.D.	X	S.D.	X	S.D.	X	S.D.
0 Days	26.65	3.26	22.89	4.94	15.96	5.10	14.47	3.36
7 Days	21.24	3.86	18.77	5.09	12.34	9.80	14.34	4.61
30 Days	16.96	4.88	18.36	6.12	14.35	3.34	14.77	4.25

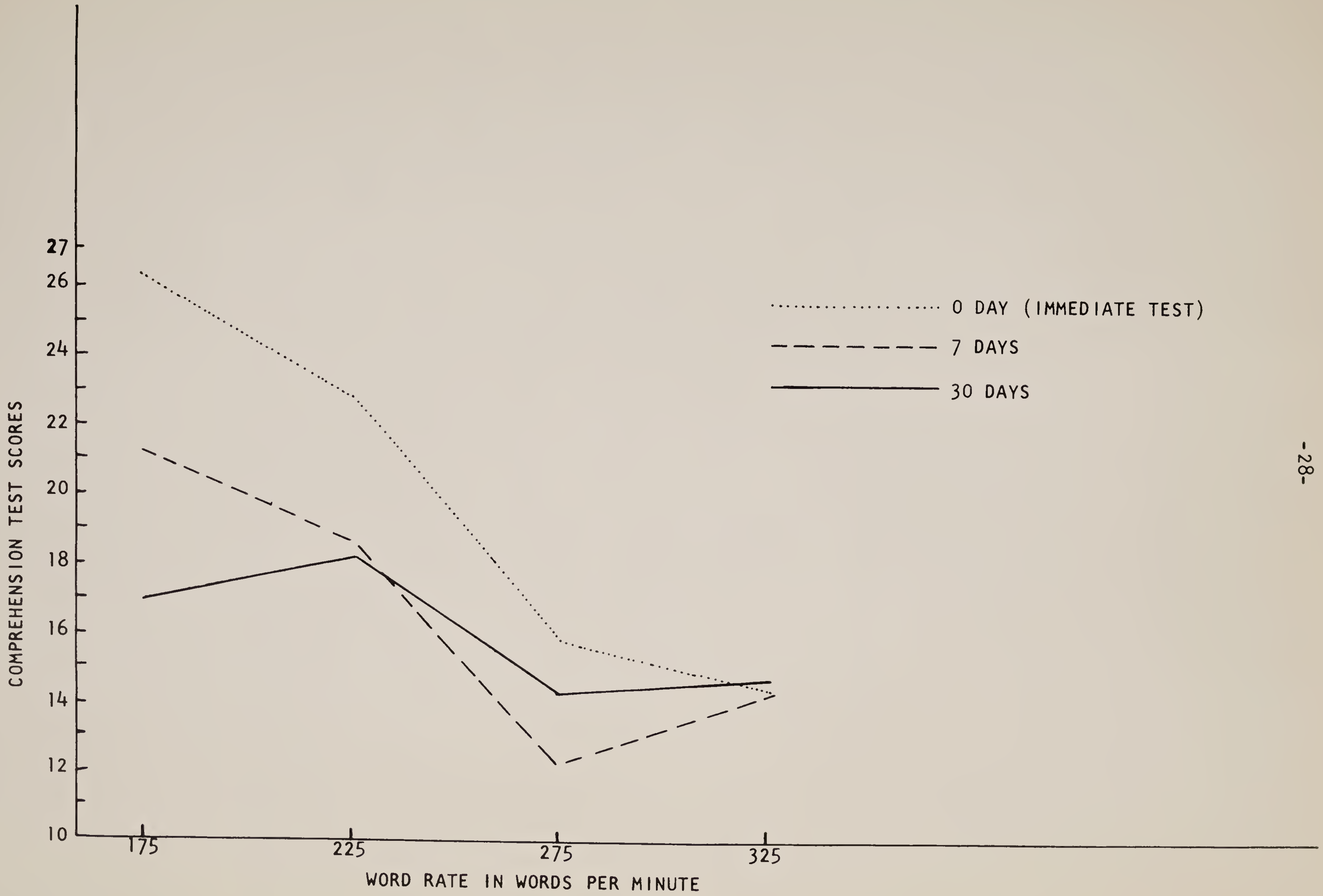

Fig. 5.1. COMPREHENSION AS A FUNCTION OF WORD RATE AFTER THREE RETENTION INTERVALS

Table 5.2

The Analysis of Variance of Retention Test Scores

Source of Variation	Sums of Squares	df	Mean Squares	F	F(.01)
Between Word Rates	3,568.83	3	1,189.61	39.85	3.88
Between Retention Intervals	992.89	2	496.45	16.63	4.71
Interaction: Word Rate X Retention Interval	420.97	6	70.16	2.35	2.14
Within Groups	9,074.31	303	29.85		
Total	14,027.00	314			

word rate. The forgetting of material learned to a given degree of mastery will occur at the same rate and be subject to the same factors, regardless of the word rate at which the material was presented during original learning. It is the amount learned originally with which we must be concerned.

In the present study, the amount learned decreased rapidly as word rate was increased. This was due in part to the fact that subjects had no previous experience in listening to material at an accelerated word rate. Research has indicated that even with moderate amounts of practice, the relationship between word rate and the amount learned would have been affected favorably, (Voor, 1962).

The amount learned decreased more rapidly as word rate was increased in the present study than in previous research (Foulke, _et al_., 1962) in which similar learning materials were administered to a subject sample of the same age - grade range. However, the subjects in the earlier experiment were blind school children who were accustomed to learning by listening, and for whom the prospect of more rapid aural communication was a motivating factor. The children in the present experiment were sighted and the task presented by the experimenter was probably not as meaningful for them.

For the reasons just cited, circumstances were not as favorable for learning by listening to rapid speech as they might have been. Nevertheless, a reasonable conclusion to be drawn from the experiment is that rapid speech poses no special problems as far as retention is concerned.

Summary: In order to explore the retention of material presented at accelerated word rates, a two-factor experiment was performed in which word rate and retention interval were varied. The word rates employed were 175, 225, 275, and 325 wpm. The retention intervals were zero days, 7 days and 30 days. Three hundred fifteen junior high school children served as subjects. The subjects were divided into twelve treatment groups and each group listened to a 2105 word selection reproduced by the speech compression technique at one of the four word rates used in the experiment, and was tested after the appropriate retention interval by a four alternative multiple choice test with a reliability of .80. The analysis of variance of test scores revealed an over-all significance for both independent variables and for their interaction. The results suggested that the retention of material learned by listening to "rapid speech" was not different than the retention of material presented by more conventional means.

Chapter Six

Summary and Conclusions

Summary: During the past two years, we have set for ourselves three broad objectives: a) to develop equipment and become experienced in the technique of compressing speech; b) to acquire the background of experience in listening to "rapid speech" as a source of experimental hypotheses; c) to plan and conduct experiments for the purpose of determining the influence upon the comprehension of "rapid speech" of a variety of possibly relevant variables and to utilize what is learned in formulating and evaluating methods of training listeners to comprehend "rapid speech" better.

The Tempo-Regulator (see page 4) is the speech compression device that has been used in this project. To the writer's knowledge, it is the best of the available compressors. However, before it could be used conveniently, many adaptations were required and accessory equipment had to be constructed. Also, the device had to be calibrated so that it could be adjusted precisely for desired amounts of speech compression. This objective has largely been accomplished. We are now able conveniently to produce recorded tapes of "rapid speech", for playback on conventional tape recorders, at any desired word rate from less than 25 wpm to more than 400 wpm.

Those of us associated with the project have now had extensive experience in listening to "rapid speech". We have listened to passages that ranged from fervent poetry to technical treatises. We have listened to these passages at a variety of word rates. We have held the word rate constant during some listening sessions, and varied it during others. We have varied the length of listening sessions.

The experience thus gained has been used to generate many hypotheses about the comprehension of "rapid speech". Some of these hypotheses have been tested by experiments described in this report. Others await investigation.

One factor that has received attention is the method of producing "rapid speech". Two methods have been evaluated. One method, the sampling method, produces speech which, though accelerated, is not distorted in pitch or timbre. However, the equipment required for this method is expensive and scarce. The other method, the speed changing method, produces speech which becomes increasingly distorted in both pitch and timbre as the amount of compression is increased. However, the equipment needed for this kind of compression is readily available and cheap enough so that it could be owned by individual listeners. The results of research on this problem are mixed and inconclusive. Further research is needed to answer this question, and the question is an important one from a practical point of view.

Certain factors are, to some extent, under the control of the experimenter when he chooses material to be compressed. Among these are the kind of material to be compressed, the word rate of that material when compressed, the word rate at which the material is read originally or before compression, and the voice quality and reading style of the reader. The first two of these factors have received some investigation. (Foulke, et. al, 1962) The third factor mentioned is under investigation at this time. The fourth factor has been examined in an

experiment described in this report (Chapter Four). In this experiment a listening selection was read by three professional readers who differed with respect to voice quality and reading style. This selection was reproduced at a normal word rate and at 300 wpm. The comprehension of the six resulting versions was measured by an appropriate test of comprehension. There was some difference in comprehension that could be attributed to the difference in readers. However, this difference was present at both the normal and the fast word rates. We had expected that the reader's influence upon comprehension would be different at a fast word rate than at a slow word rate. We hope to give this matter further attention at a later date.

The question of the listener's ability to retain what he has learned at an accelerated word rate has been raised by many. In order to illuminate this question, we have performed an experiment in which both word rate and retention interval were varied. Both variables contributed significantly to the outcome of the experiment. However, it was not possible to conclude that the retention of "rapid speech" constituted a special case. What has been found regarding the retention of material presented at a conventional word rate appears to be true for material presented at a fast word rate as well.

The experience gained in listening to "rapid speech" has suggested two variables that appear to be relevant as far as training methods for the comprehension of "rapid speech" are concerned. One of these is the word rate at which material is presented during training. The other is the attentive adjustment of the listener during training. It was initially planned to evaluate these two variables in a single experiment. However, because of practical difficulties, it was necessary to evaluate the influence of each variable separately. Training consisted in giving all subjects extensive experience in listening to "rapid speech". In the experiment in which the effect of word rate on training was examined, one group heard the training material at a constant word rate of 350 wpm, while the other group heard material the word rate of which was very slowly increased from a normal word rate to a final rate of 350 wpm.

The second training experiment, designed to secure a better attentive adjustment on the part of the listener, was a replication of the first with the exception that the listening selection was interrupted frequently so that listeners could be questioned about the material just heard. Subjects were given equivalent tests of listening comprehension, one prior to and one after training. Comparisons of pre-training and post-training test scores provided the evidence for success in training. The outcomes of the two experiments were similar, both with respect to differences found and mean test scores earned. Neither of the methods tested were effective in bringing about an improvement in the ability to comprehend "rapid speech". However, some of the subjects in each experiment demonstrated good comprehension of "rapid speech" without training.

Conclusions: It is apparent that much of the research reported in the preceding pages has not been successful in the sense that expectations have not been realized. However, this is an instance in which negative results are also informative.

One general conclusion that is warranted by the accumulated results is that in order for the kind of experimental comparisons that we have been making to be meaningful, they must involve subjects who have received much larger amounts of prior experience in listening to "rapid speech". The experiments conducted so far have used naive subjects. These experiments have been designed to test hypotheses generated from the extensive listening experience of those of us associated with the

project. We now believe that the demonstration of many of the relationships with which we have been concerned presupposes training, formal or otherwise, in the comprehension of "rapid speech". A good example is afforded by the experiment in which a comparison was made of alternative methods of accelerating speech, (Chapter Three). Listeners who, in the course of working on the project, had accumulated large amounts of experience in listening to speech accelerated by both methods, were quite confident about the outcome of this experiment. The superiority of the "sampling method" seemed to them beyond question. Yet when an experiment using naive subjects was performed, this superiority could not be demonstrated. It appears that, although the two kinds of "rapid speech" are equally comprehensible for inexperienced listeners, practice is more beneficial in one case than in the other.

On the basis of the argument just presented, it is felt that many future experiments will require as subjects people who have received training in the comprehension of "rapid speech". Meeting such a requirement would greatly increase the money and time required for the conduct of experiments. Nevertheless, these costs must be borne if many of the relevant questions concerning the comprehension of "rapid speech" are to be pursued further.

Another conclusion, based upon the experience gained during the conduct of many experiments, is that more elaborate steps must be taken to insure the motivation of subjects in "rapid speech" experiments. When sighted public school children have served as subjects, they have, as often as not, regarded service in the experiment as little more than welcome relief from the normal school routine. Listening to "rapid speech" has clearly been a more meaningful experience for blind school children and, in general, they have been better experimental subjects. However, even here, we have had subjects go to sleep during listening sessions.

As far as training is concerned, both the conclusions just discussed are pertinent. In our next training effort, we plan to provide subjects with considerably more experience in listening to "rapid speech" before we evaluate its comprehension. We plan to use as subjects children who read extensively by listening for their own entertainment, and not just to meet requirements imposed on them by their teachers. We plan to prepare for them, at accelerated word rates, the kind of reading material that they would have chosen for themselves. Under these conditions, we feel that we will be able to demonstrate the extent to which the ability to comprehend "rapid speech" can be trained.

One final conclusion merits consideration. Throughout our research we have observed that some listeners show excellent comprehension of "rapid speech" even without training. We feel that it would be desirable to compose experimental groups on this basis, and to study the characteristics of these superior listeners more carefully. The results of such an analysis should guide us in a more selective application of "rapid speech" techniques, and should provide insight regarding more effective training methods.

References

Allen, M. P. "Two Chests of Treasure", *Reading Roundup Number Two*. D. C. Heath & Co., Boston, 1958.

Arnston, H. E. *Adam Gray: Stowaway*. Franklin Watts, Inc., 1961.

Bixler, R. H., Foulke, E., Amster, C. H., and Nolan, C. Y. The Comprehension of Rapid Speech: Part I. Cooperative Research Project #1005, 1961.

Dale, E., and Chall, J. S. A formula for predicting readability. *Educ. res. Bull.*, 1948, *27*, p. 11 - 12, 37 - 54.

Durant, Will. "Athenian, Spartan and Roman Life", *Ideas and Backgrounds*. American Book Company, New York, 1957.

Ethington, Doris. The readability of Braille as a function of three spacing variables. Unpublished master's thesis, Univer. of Kentucky, 1956.

Fairbanks, G., Guttman, N., and Miron, M. Effects of time compression upon the comprehension of connected speech. *J. Speech Hear. Dis.*, 1957, *22*, p. 10-19.

Foulke, E. A comparison of two methods of compressing speech. Symposium Paper, Southeastern Psychological Association, 1962.

Foulke, E., Amster, C. H., Nolan, C. Y., and Bixler, R. H. The Comprehension of Rapid Speech by the Blind. *J. Except. Children*, *29*, 1962, p. 134 - 141.

Harris, A. J. *How to Increase Reading Ability*. New York: Longmans, Green and Co. 1947.

Klineman, Janet. The effects of training sessions on the ability to comprehend compressed speech. Unpub. professional paper, Univer. of Pittsburgh, Oct., 1963.

McLain, Julie R. A comparison of two methods of producing rapid speech. *Internat. J. for the Educ. of the Blind*, *12*, 1962, p. 40 - 43.

Sequential Tests of Educational Progress. Cooperative Test Division, Educational Testing Service, Princeton, New Jersey, 1957.

Voor, John B. The effect of practice upon the comprehension scores of time compressed speech. Unpub. master's thesis, Univer. of Louisville, 1962.

White, Milton P. "The Yellow Turtleneck Sweater", *Prose and Poetry Adventures*, Iverson, 1957.

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